







The classroom relational environment and children's early development in preschool

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Abstract

The present study considered the ways in which interactional quality in the classroom and teacher-child relationships independently and synergistically shaped the early academic, social-behavioral, and executive function outcomes of 1,498 preschoolers from low-income families from a large, culturally, and linguistically diverse county. The findings revealed that children who had closer and less conflictual relationships with their teachers demonstrated greater improvements in all domains of school readiness across the preschool year. Moreover, preschool attendees did not reap the maximum academic benefits from high quality classroom environments unless they also had high-quality individual relationships with their teachers. Implications for policy and practice are discussed.

KEYWORDS

preschool, school readiness, social interaction, teachers

1 | INTRODUCTION

Prior research on the quality of teacher-child interactions generally has examined the average child experience in the preschool classroom and documented modest associations with children's early learning and development (e.g., Burchinal et al., 2000; Burchinal, Vandergrift, Pianta, & Mashburn, 2010; Pakarinen et al., 2011; Rimm-Kaufman, Curby, Grimm, Nathanson, & Brock, 2009). However, even with the national push for preschool expansion and the large investments in the quality of children's early educational experiences (Phillips et al., 2017; Yoshikawa et al., 2013), there has been little effort to understand whether all children benefit from a high-quality classroom environment, or whether to benefit from these environments individual children need a positive relationship with their teachers. In the present investigation, we bridge two literatures that have, for the most part, separately considered the effects of interactional quality at the classroom level and relationships at the dyadic

level. We consider both the independent and synergistic effects of classroom interactional quality and teacher-child relationship quality among a sample of children who attended preschool in a large, culturally, and linguistically diverse county in the mid-Atlantic region of the United States.

1.1 | Theoretical perspective

The literature on classroom relationships and interactions is largely informed by attachment theory (Bowlby, 1969) and developmental systems theory (Bronfenbrenner & Morris, 1998; Lerner, 1998; Sameroff, 1995). Guided by Bowlby's (1969) theoretical notions on parent-child relationships, and central to the attachment perspective, is the idea that children derive feelings of safety and well-being from relationships with the adults with whom they interact. In the classroom context, teachers are seen as alternate caregivers (Howes, 2000), and although this relationship is not as exclusive and durable as the relationship that most children have with their parents, a positive teacher-child relationship creates feelings of security and support (Birch & Ladd, 1997; Hamre & Pianta, 2001; Pianta, 1999). In turn, this secure base for children encourages them to take risks and actively engage with and explore the classroom environment, thereby fostering their learning and development (Sroufe, 1988; Verschueren & Koomen, 2012). In contrast, a poor relationship with teachers will elicit feelings of insecurity and distress in children, resulting in less academic and social growth (Pianta, 1999).

Relatedly, developmental systems theory (Bronfenbrenner & Morris, 1998; Lerner, 1998; Sameroff, 1995) posits that these individual teacher-child relationships are embedded within multiple dynamic systems. Specifically, teacher-child relationships are situated in classrooms and developmental systems theory suggests that individual teachers and children are part of this larger context that may support or inhibit the development of positive relationships (Myers & Pianta, 2008). Thus, to understand the dynamics and consequences of classroom interactional quality and dyadic relationship quality more fully, accounting for the continuous interactions of multiple factors in multiple contexts is necessary (Pianta, 1999; Sroufe, 2005). Together, these theoretical frameworks provide an integrated perspective for understanding the relational aspects of the classroom environment in shaping children's learning and development.

1.2 | Quality of classroom interactions

One of the primary objectives of preschool programs is to provide children with the foundational skills necessary to succeed in elementary school and beyond (Phillips et al., 2017; Yoshikawa et al., 2013). To achieve this goal, theory suggests that teachers must provide children with opportunities to express existing skills and scaffold more complex ones (Davis & Miyake, 2004; Skibbe, Behnke, & Justice, 2004; Vygotsky, 1978). Drawing on the Classroom Assessment Scoring System (CLASS) framework (Hamre & Pianta, 2007; Pianta, La Paro, & Hamre, 2008), three dimensions of classroom interactions have been emphasized in the developmental literature: (1) emotional support (2) classroom organization, and (3) instructional support.

Using the CLASS framework, a number of studies have considered the associations between classroom interactions and children's early learning and development. For example, previous research in this area demonstrates that children in more emotionally supportive classrooms show greater gains in reading, math, executive functioning, and social skills (Burchinal et al., 2010; Hamre & Pianta, 2005; Rimm-Kaufman et al., 2009; Weiland, Ulvestad, Sachs, & Yoshikawa, 2013). Teachers who emphasize conceptual understanding, provide feedback, and engage children in conversations during instruction have been found to promote children's gains in literacy, language, and math outcomes (Aikens, Klein, Tarullo, & West, 2013; Burchinal et al., 2010; Howes et al., 2008; Mashburn et al., 2008). Despite the potential benefits of interactional quality for children's early learning and development, the average effect size generally ranges from .05 to .10 (Burchinal, 2018; Perlman et al., 2016). The magnitude of these

associations has raised questions about why the effects of classroom interactional quality are modest, with some suggesting that there may be individual-level factors that uniquely contribute to and moderate the links between classroom interactions and children's outcomes (Burchinal, 2018; Perlman et al., 2016).

1.3 | Individual teacher–child relationships

In addition to the quality of classroom-level interactions, children's individual relationships with their teachers also have been at the forefront of decades of developmental research (e.g., Birch & Ladd, 1997; Hamre & Pianta, 2001; Howes & Matheson, 1992; Howes, Matheson, & Hamilton, 1994; Lynch & Cicchetti, 1992; Pianta & Nimetz, 1991; Pianta, Steinberg, & Rollins, 1995). Whereas the literature on the quality of classroom interactions discussed above focuses on the average level of support experienced by children in a classroom as a whole, teacher–child relationships consider individual experiences. Teacher–child relationships typically are viewed as consisting of two dimensions: closeness and conflict. Closeness represents high levels of warmth, positive affect, and approachability between teacher and child (Pianta, 1999; Pianta et al., 1995) whereas conflict represents negativity and lack of rapport (Ladd & Burgess, 2001).

Although there are a number of methods and measures used to capture teacher–child relationships, they often are based on teachers' perceptions, as they are in the current study. The most commonly utilized tool from the teacher's perspective is the student–teacher relationship scale (STRS; Pianta, 2001), an empirically validated teacher report of their perceived relationship quality with individual children, which has been shown to correlate with observational measures of teacher–child relationship quality (Howes & Hamilton, 1993; Howes & Ritchie, 1999). As children grow older, studies also have incorporated students' reports of their relationship quality with their teachers (Hughes, 2011; Koomen & Jellesma, 2015; Rey, Smith, Yoon, Sommers, & Barnett, 2007), as well as peers' perceptions of their classmates' relationships with the teacher (Hughes, Cavell, & Willson, 2001; Hughes, Zhang, & Hill, 2006).

Teachers might provide more support and attention to children with whom they have a close and conflict-free relationship (Birch & Ladd, 1997; Hamre & Pianta, 2001). They are likely to offer children positive instructional and behavioral supports, and teach coping skills that encourage children's development of social-behavioral skills and self-regulation (Cadima, Verschuere, Leal, & Guedes, 2016; Howes & Hamilton, 1993; Pianta, 1997; Rudasill et al., 2016; Silva et al., 2011). These positive relationships can provide a context in which children are emotionally secure and confident, which encourages them explore classroom resources and the learning environment actively (Pianta, 1999). A low-quality relationship fraught with conflict may lead teachers to become frustrated with children and hinder teachers' abilities to provide a supportive learning environment. Children's misbehavior that elicits negative reactions may distract teachers from instructional goals and instead lead them to focus on discipline. In turn, this may lead to greater difficulty for children's adjustment and engagement (Pianta et al., 1995), and contribute to children's negative attitudes toward school (Silva et al., 2011).

In support of these possibilities, both positive and negative aspects of teacher–child relationships have been found to shape children's classroom experiences and have downstream implications for their learning and development (Hamre & Pianta, 2001; Pianta & Stuhlman, 2004; Spilt, Hughes, Wu, & Kwok, 2012). More specifically, children who have a warm and close relationship with their teachers demonstrate stronger academic test scores and social-behavioral outcomes (Hamre & Pianta, 2001; McCormick, O'Connor, Cappella, & McClowry, 2013; O'Connor, Dearing, & Collins, 2011; Pianta, 1999) whereas those who have a negative relationship or demonstrate conflict with their teachers display less optimal developmental outcomes (Baker, Grant, & Morlock, 2008; Birch & Ladd, 1997; Howes, 2000; Pianta & Nimetz, 1991). A meta-analysis by Roorda, Koomen, Spilt, and Oort, (2011) showed that the association between teacher–child relationships and academic achievement is especially strong in the case of negative relationships, and particularly for younger children. The robust correlational literature on teacher–child relationships and children's school readiness reports absolute effect sizes ranging from .01 to .34 (Cadima et al., 2016; Graves & Howes, 2011; Pianta & Stuhlman, 2004; Roorda et al., 2011).

1.4 | Synergistic effects of classroom interactions and teacher–child relationships

Although both individual teacher–child relationships and the quality of teacher–child interactions at the classroom-level matter for children's early learning and development (e.g., Hamre & Pianta, 2001; Mashburn et al., 2008), few studies have examined how these dynamics may work together to shape children's school readiness. This is surprising because the dynamics of teacher–child relationships are embedded within the larger context of classroom interactions (Howes et al., 2011), and thus, it seems important to consider both as facets of the classroom environment that promote children's early learning (Pianta, Hamre, & Stuhlman, 2003). It is likely that children in the same classroom have different experiences of the classroom context based on their unique relationships with the teacher. Further, the degree to which a teacher is close or in conflict with individual children can shape the overall classroom environment. For example, teachers' emotions and affective responses toward a particular child can influence how teachers individualize their interactions and instruction, and consequently how they interact and instruct the classroom more generally. Teachers who establish positive relationships with individual children may be more likely to provide a more supportive classroom environment for all students in the classroom (Hamre & Pianta, 2007; Pianta et al., 1995). The availability of a well-organized and emotionally and instructionally supportive environment for all children in a classroom also might mean that all children have the opportunity to experience an environment that amplifies a supportive teacher–child relationship.

There is likely to be variability in teachers' relationships with individual students in the classroom. The overall classroom environment might be characterized by high-quality interactions, but there could be individual children who are not benefitting from this because they have low-quality relationships with their teacher. Findings from previous work on classroom interactional quality suggest that high-quality interactions can act as a buffer for children who are at risk for conflictual relationships with their teachers. Buyse, Verschueren, Doumen, Van Damme, and Maes (2008) found that classroom emotional support attenuated the associations between children's behavior problems and high levels of teacher–child conflict in a sample of Dutch kindergarteners. Additionally, prior work has shown that preschool children's temperament (i.e., effortful control, anger, and shyness) may be linked strongly to the quality of their relationships with teachers and consequently interact with the levels of emotional and instructional support they receive in the classroom (Rudasill et al., 2016).

There are a few additional studies that examine classroom-level and individual-level dynamics together, and results suggest that relationships at the individual level have a stronger link to children's outcomes than interactional quality (Graves & Howes, 2011; Jeon et al., 2010; Lippard, La Paro, Rouse, & Crosby, 2018; Rudasill et al., 2016). For example, Graves and Howes (2011) documented significant associations between teacher–child relationships, as measured by the STRS, and children's peer social skills, frustration tolerance, and conduct problems, but there were no significant associations of the classroom's emotional climate as measured by the CLASS with these dimensions of social-emotional functioning. In a sample of students in third to fifth grade, Rucinski, Brown, and Downer (2017) hypothesized that a positive classroom emotional climate, as measured by the CLASS emotional support domain, would serve as a buffer against negative outcomes for children, and low-quality individual teacher–child relationships would be a risk factor for negative outcomes. These authors documented associations between teacher–child relationship quality and children's social-emotional and academic outcomes; however, classroom emotional support was not linked directly with children's outcomes, and there was limited evidence that a positive classroom emotional climate acted as a protective factor for children with negative teacher–child relationships. In contrast, Lippard and colleagues (2018) found that positive teacher–child relationships (as measured by the Caregiver Interaction Scale; Arnett, 1989) partially compensated for classrooms considered low in emotional sensitivity (Lippard et al., 2018). Taken together, the literature in this area provides inconclusive evidence regarding whether teacher–child relationships and classroom-level interaction quality operate synergistically to promote children's development.

1.5 | Current study

The current study provides unique insight into the ways in which interactional quality and relationships matter independently and synergistically for children's early learning and development by investigating *both* classroom-level teacher-child interactions and individual children's relationships with teachers in preschool. We explored two research questions: (a) To what extent do children's developmental gains (i.e., academic achievement, social-behavior, and executive function) in preschool vary as a function of the quality of teacher-child interactions, teacher-child closeness, and teacher-child conflict? (b) Do teacher-child closeness and conflict moderate the associations between the quality of teacher-child interactions and changes in children's learning and development? In addressing these research questions, our study addresses important gaps in knowledge regarding the ways in which individual children's relationships with their teacher and the classroom environment are associated with developmental gains across the pre-K year.

2 | METHOD

2.1 | Participants

Participants included 1,498 children from a large, culturally and linguistically diverse county, recruited across 156 classrooms in publicly funded center-based preschools within a school district. Children were 50% male, 55.01 months old at the start of the study ($SD = 3.51$), and 55% of children spoke Spanish at home. Children were ethnically diverse, with the sample comprised of 60% Hispanic/Latino, 17% Black/African American, 10% White, 9% Asian, and 4% multiracial, Native American, or other ethnicities. Income-to-needs ratios indicated that on average, families were living in poverty ($M = 0.86$, $SD = 0.53$). The majority of teachers were White (66%) and had approximately 16 years of teaching experience ($SD = 10.11$) on average. Table 1 presents descriptive statistics on the teachers and children.

2.2 | Study procedures

2.2.1 | Recruitment

Teachers were recruited from the entire population of school and community-based pre-K program classrooms in the county. All teachers in the public schools were eligible; teachers in the community programs were eligible if they taught at a center in which more than five publicly funded pre-K children were enrolled. A total of 100 teachers from public schools and 56 from community programs were recruited initially. With the assistance of program staff, we identified a list of community child care centers that either were publicly funded (e.g., Head Start) or included slots for publicly funded children to attend. We sent a flyer to center directors describing the project and followed up by contacting centers individually. If center directors indicated that they were interested in participating, the research team, in coordination with program staff, contacted teachers to describe the project in more detail and obtain teachers' consent.

For the public schools, project information was distributed to teachers by the district coordinator. Teachers who opted to participate returned consent forms to the research team. Once we received a consent form, we considered the teacher to be enrolled in the study. Of the 156 recruited teachers, 126 met eligibility requirements and enrolled in the study (87 from public schools, 39 from community programs). A subset of seven enrolled teachers opted not to participate in teacher-level data collection but allowed the research team to conduct assessments with participating students in their classrooms. At the beginning of the school year, participating teachers sent all

TABLE 1 Descriptive statistics for the study sample

	M	SD
<i>Quality of teacher-child interactions</i>		
CLASS emotional support	5.36	0.59
CLASS classroom organization	5.45	0.52
CLASS instructional support	2.44	0.48
<i>Quality of teacher-student relationship</i>		
STRS closeness		
Fall	4.04	0.87
Spring	4.33	0.74
Fall and spring	4.18	0.74
STRS conflict		
Fall	1.58	0.88
Spring	1.55	0.82
Fall and spring	1.57	0.80
<i>Child and family characteristics</i>		
Age	55.82	3.49
Male	0.50	
Home language		
English	0.21	
Spanish	0.55	
Other	0.24	
Race/ethnicity		
White	0.10	
Black	0.17	
Hispanic	0.60	
Other	0.12	
<i>Parent years of education</i>	12.63	1.80
Income-to-needs ratio	0.86	0.53
<i>Classroom and teacher characteristics</i>		
Literacy level	1.53	0.39
Math level	1.65	0.29
Teacher-directed instruction	0.38	0.14
Child-structured activities	0.30	0.13
Routines	0.32	0.13
Time spent on academics	0.35	0.12
Classroom type		
Public school	0.62	
Head Start	0.23	
Private center	0.15	

(Continues)

TABLE 1 (Continued)

	M	SD
Proportion of classroom		
Minority	0.77	
Male	0.51	
Limited English proficient	0.56	
Special needs	0.08	
Age 3	0.12	
Age 4	0.74	
Age 5	0.14	
Teacher years of education	16.86	1.60
Teacher years of experience	15.68	9.73
Teacher is minority	0.42	
Class size	16.86	1.85
Observations (child)	1,498	

Notes: SD s are only presented for continuous variables.

Abbreviations: CLASS, classroom assessment scoring system; STRS, student–teacher relationship scale.

parents or guardians of their students a consent form and short family demographic survey to complete. Children were eligible to participate if they were enrolled in the program, turned four years of age by September 30, and were not receiving special education services (except for speech). Of the 1,878 eligible children, 1,498 children had parents who consented to participate, and thus, were the focus of data collection. All procedures were approved by the Institutional Review Board at the University of Virginia and parents and teachers received a small stipend to thank them for their time. The data are not available publically because of information that could compromise the privacy of the research participants.

2.2.2 | Data collection

Data were collected through a combination of classroom observations, surveys, rating scales, and direct assessments. Observations were conducted on two to three separate occasions during the pre-K year ($M = 2.72$, $SD = 0.49$; 74% had three observations, 25% had two observations, and 2% had one observation). During observations, data collectors observed classrooms across the morning from the start of the school day to lunchtime, alternating between assessing the quality of interactions with the CLASS (Pianta et al., 2008) and the content and dosage of instruction with the behavioral coding system (BCS), which was adapted from the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (NICHD SECCYD) and the Classroom Observation System and Observational Record of the Caregiving Environment (McCartney, Dearing, Taylor, & Bub, 2007; Pianta et al., 2008; Ritchie, Howes, Kraft-Sayre, & Weiser, 2001). At the start of the school year, parents reported on family income and the number of children and adults in the home. Teachers completed a survey in the fall (September through November) and spring (April through May) reporting their demographic characteristics and experience; the demographic composition of their classrooms; and their attitudes, knowledge and beliefs about teaching. Additionally, teachers completed rating scales on each participating child's social-behavioral skills and individual relationships in the fall and spring. Almost all teachers in our study completed the surveys. Finally, the schools supplied information on children's date of birth gender, home language, and race/ethnicity.

TABLE 2 Descriptive statistics of child outcomes

	Fall of preschool		Spring of preschool		Classroom-level ICC
	M	SD	M	SD	
<i>Academic outcomes</i>					
Letter-word identification	91.85	14.80	97.47	13.45	0.05
Picture vocabulary	91.51	14.86	96.63	12.22	0.12
Applied problems	86.84	13.45	89.06	11.33	0.05
Quantitative concepts	89.24	12.33	91.18	14.17	0.06
<i>Social-behavioral</i>					
Behavior problems	1.84	0.93	1.79	0.91	0.14
Social competence	3.51	0.78	3.72	0.81	0.26
Task orientation	3.44	0.92	3.67	0.96	0.17
Frustration tolerance	3.25	0.94	3.39	1.00	0.30
<i>Executive functioning</i>					
Backward digit span	1.18	0.52	1.42	0.76	0.00
Head, toes, knees, shoulders	14.91	22.43	30.86	27.75	0.03
Pencil tap	7.77	5.57	11.41	5.00	0.02

All eligible children in a classroom were administered assessments in the fall and spring by trained data collectors. Data collectors completed a one-day training to learn the measures prior to assessing children. Children were assessed in a quiet space, outside of the classroom when possible. Children were assessed in English unless they failed the language screening (PreLAS; Duncan & De Avila, 1998); if this was the case, and if they spoke Spanish, then, they were assessed with parallel Spanish measures (for the academic outcomes only) in the fall of pre-K in addition to the English assessments. However, in the spring, all children were assessed in English because prior analyses with this sample using the fall PreLAS indicated the fall assessment underestimated children's skills in English. Given the increased exposure to English in the ensuing months, it also was assumed that children's English skills would increase and the PreLAS would be an even less valid screener. Procedures were instituted through which data collectors asked teachers to review the names of children scheduled for assessment on a given day and indicate whether they thought the child was capable of understanding the test directions and responding in English. If the teacher indicated concerns, the child's data were flagged and not included in the analyses. The present study utilized only the English-language assessment data for children indicated by teachers or by the Pre-LAS as capable of participating in the assessment. Fewer than 15 students were flagged by teachers.

2.3 | Measures

Below, we describe each of our key measures, including the quality of teacher-child interactions, teacher-child relationship, and developmental outcomes, in turn. All reliability coefficients provided for each of the measures are specific to the study sample. Descriptive statistics of all the quality of interactions and teacher-child closeness and conflict are presented in Table 1. Descriptive statistics of child outcomes are presented in Table 2.

2.3.1 | Quality of teacher–child interactions

Teacher–child interaction quality was measured with the CLASS. This widely used measure assesses the average classroom quality based on 10 dimensions, each of which are rated from 1 to 7, with higher scores indicating higher quality interactions. Dimensions are collapsed to form three domains: Emotional Support, capturing teacher sensitivity, promotion of autonomy, and climate; Classroom Organization, capturing the degree to which teachers manage behavior and use time and materials effectively to acquire the most out of the day; and Instructional Support, capturing teachers' promotion of higher order thinking and language. All data collectors attended a two-day training session led by the project investigators and staff, all of whom are experts on the CLASS. Data collectors had to be deemed reliable and certified on the tool in order to conduct observations. Specifically, raters were trained to an initial level of 80% agreement (within 1-point) to be certified for collection of data in the field. Observers conducted four cycles of observations (each cycle includes 15 min to observe, 10 min to score) during each classroom visit across two to three separate occasions throughout the year. Data collector reliability was maintained with refresher training before data collection and bi-monthly calibration meetings throughout the study year. Twenty percent of all cycles were double coded to determine inter-rater reliability ($ICC = 0.725$). We composited these ratings across dimensions and across occasions of observation into a single overall domain of interaction quality ($\alpha = .85$).

2.3.2 | Individual teacher–child relationships

Individual teacher–child relationship quality was measured from the teachers' perspective in the fall and spring of the pre-K year. Each participating child's relationship with his or her teacher was measured by the STRS (Pianta, 2001). The STRS is comprised of 15 items, asking teachers to report on their perspectives of their relationships with individual children in the classroom. We adapted this measure and asked teachers to respond to nine of the 15 items. Specifically, five items are included in the *conflict* score ($\alpha = .82$), where teachers are asked about the extent to which they perceive negative interactions and emotions with the child. Four items are included in the *closeness* score ($\alpha = .78$), where teachers report on the degree of warmth and open communication they share with the child. For the current analyses, items were averaged across the fall and spring within their respective subscales.

2.3.3 | Academic achievement

Children's academic skills were assessed with four subtests from the Woodcock-Johnson III Psychoeducational Battery (WJ-III; Woodcock, McGrew, & Mather, 2001). More specifically, children's literacy skills were assessed with the Letter-Word Identification subtest, which asked children to identify individual letters and words ($\alpha = .81$). Next, children's language skills were assessed with the Picture Vocabulary subtest ($\alpha = .80$), which required them to identify objects that were presented in a series of pictures. Additionally, two subscales of the WJ-III were administered to measure children's math skills: (a) Applied Problems ($\alpha = .78$), which required children to perform basic math calculations in response to orally presented problems and (b) Quantitative Concepts ($\alpha = .80$), which asked children to identify number patterns. For the purposes of the present study, we used the standard scores that were nationally normed and describe children's academic performance relative to the average performance of their same-age peers.

2.3.4 | Social-behavioral skills

Teachers rated each child on four general domains of social-behavioral skills using the Teacher-Child Rating Scale (Hightower, 1986). Teachers were directed to indicate how well a given characteristic described the child (1 = *not at all*, 3 = *moderately well*, 5 = *very well*). The task orientation subscale (e.g., completes work, well organized, functions well even with distractions, and works well without adult support; $\alpha = .92$), peer social skills subscale (e.g., has many friends, is friendly toward peers, and makes friends easily; $\alpha = .93$), and frustration tolerance subscale (e.g., accepts things not going his/her way, ignores teasing, copes with failure; $\alpha = .90$) were comprised of five items each. The fourth and final dimension, conduct problems, was based on six items (e.g., disruptive in class, defiant, overly aggressive with their peers; $\alpha = .89$).

2.3.5 | Executive functioning

Children's executive function skills were assessed using three measures that have been used extensively in the developmental literature. Working memory was assessed with the Backwards Digit Span (Carlson, 2005), which asked children to repeat in reverse sequences of numbers that increase in length ($\alpha = .60$). Next, the Head-Toes-Knees-Shoulders assessment ($\alpha = .74$; McCabe, Cunnington, & Brooks-Gunn, 2004; McClelland et al., 2008) was used to examine a combination of children's inhibitory control, attention, and working memory. Additionally, inhibitory control was assessed using the pencil tap task ($\alpha = .66$; adapted from Diamond & Taylor, 1996; see Smith-Donald, Raver, Hayes, & Richardson, 2007). This assessment asks children to tap once when the assessor taps twice and vice versa. Percent of correct responses on this assessment has demonstrated good concurrent and construct validity with other measures of inhibitory control as well as predictive validity for school readiness outcomes (Blair & Razza, 2007; Smith-Donald et al., 2007).

2.3.6 | Covariates

To reduce the possibility of spurious associations, we control for a rich set of child, family, and classroom covariates. The child- and parent-level covariates included child gender, age at assessment, home language, race/ethnicity, parent education, and household income-to-needs ratio. Our analytic models also included the lagged dependent variables for each of the respective outcomes as well as the time lag between assessments, which is one of the strongest adjustments in the context of a non-randomized control trial (NICHD Early Child Care Research Network & Duncan, 2003). Drawing on teacher surveys, classroom observations, and administrative data, we used the following teacher and classroom covariates in our analyses: classroom type, percent of classroom children who were a minority, male, English learner, and had special needs; classroom age composition; teacher education, experience, race/ethnicity; percentage of academic and teacher-directed instruction (using data from the random selection of four students in the classroom); amount of child-selected activities; percentage of basic and advanced math and literacy content; and class size.

3 | RESULTS

Using a regression-based framework, we examined the associations between classroom-level teacher-child interaction quality and individual children's relationships with teachers on their academic, social-behavioral, and executive function outcomes in preschool. Our models included clustered standard errors to account for the nesting of children in classrooms. Missing data occurred most often on our covariates (mean of 8%, range = 0% to

21%). We accounted for missing data using the Full Information Maximum Likelihood (FIML) procedure in Stata 15.0 (Enders, 2001). FIML uses all available information within cases to estimate the missing parameters so that incomplete observations can be included to calculate estimates. All key variables of interest were standardized to have a mean of zero and a *SD* of one so that coefficients can be interpreted as effect sizes in *SD* units.

Our first set of analyses examined the main effects of all key predictors and moderators. In separate models for each of the outcomes, we regressed the school readiness outcome of interest on the quality of teacher-child interactions, teacher-child closeness, and teacher-child conflict. After establishing the main effects of these variables, we examined whether teacher-reported closeness and conflict moderated the association between the quality of teacher-child interactions and children's school readiness outcomes. The interactions between classroom quality and teacher-reported closeness and conflict were examined in two separate models and also included the full set of covariates.

We elected to collapse the three CLASS domains into one total classroom quality score because of the high correlations between the individual domain scores. Previous research has also indicated that collapsing the scores is acceptable (Pianta et al., 2020; Vitiello, Bassok, Hamre, Player, & Williford, 2018). As an additional check, we estimated our models with the three individual domain scores and found the same pattern of results (available upon request).

3.1 | Main effects of classroom quality and teacher-child relationships

As can be seen in Table 3, results from our main effects analyses revealed that the quality of teacher-child interactions in preschool was *not* related significantly to children's early academic learning, social-behavioral development, or executive function skills, with absolute effect sizes ranging from 0.01–0.05. In contrast, children who had closer relationships with their preschool teachers demonstrated significantly greater improvements on nine of the 11 school readiness outcomes of interest ($ES = 0.04\text{--}0.11, p < .05$). In addition, even though teacher-child conflict was *not* associated with relative changes in children's academic achievement across the preschool year, teacher-child conflict was related to less optimal executive function skills ($ES = 0.05\text{--}0.07, p < .05$) and less optimal social-behavioral skills ($ES = 0.14\text{--}0.49, p < .001$).

3.2 | Interactive effects of teacher-child interaction quality and relationships

Having established the main effects for the focal variables of interest, in our next set of models we tested for potential interactive effects of teacher-child interactions and relationships. Results for these analyses also are provided in Table 3. Results from these analyses revealed that of the eight interactions tested, two were statistically significant and one was marginally significant. More specifically, in terms of academic achievement, the effects of teacher-child interaction quality on children's letter-word identification ($ES = 0.04, p < .05$) and quantitative concepts ($ES = 0.04, p < .05$) were moderated by the level of closeness as reported by their preschool teachers. Turning to teacher-child interaction quality and conflict, two of the four interactions we tested were either statistically significant or marginally significant. Specifically, the effect of teacher-child interaction quality on children's picture vocabulary ($ES = -0.06, p < .01$) was moderated by the level of conflict as reported by their preschool teachers. As for the marginally significant finding, the effect of teacher-child interaction quality on children's quantitative concepts ($ES = -0.04, p < .10$) was moderated by the level of conflict as reported by their preschool teachers.

For children's social-behavioral and executive function outcomes, the only significant interaction was between teacher-child interaction quality and closeness and only for children's behavior problems ($ES = -0.04, p < .01$).

TABLE 3 Associations between teacher-child interactions and relationships, and children's school readiness outcomes

Outcome	Main effects			Interaction terms		
	Quality of teacher-child interactions	Teacher-child closeness	Teacher-child conflict	Teacher-child closeness	Teacher-child interactions × closeness	Teacher-child interactions × conflict
<i>Academic outcomes</i>						
Letter-word identification	0.01 (0.03)	0.08 (0.02) ^{***}	-0.02 (0.03)	0.04 (0.02) [*]		-0.02 (0.02)
Applied problems	0.01 (0.02)	0.09 (0.03) ^{**}	-0.01 (0.02)	0.05 (0.02) [†]		-0.00 (0.02)
Picture vocabulary	0.01 (0.02)	0.05 (0.02) [*]	-0.04 (0.02)	0.01 (0.02)		-0.06 (0.02) ^{**}
Quantitative concepts	0.04 (0.03)	0.03 (0.02)	-0.03 (0.02)	0.04 (0.02) [*]		-0.04 (0.03) [†]
<i>Social-behavioral skills</i>						
Behavior problems	-0.03 (0.03)	0.01 (0.02)	0.49 (0.05) ^{***}	-0.04 (0.01) ^{**}		0.03 (0.03)
Social competence	0.01 (0.04)	0.11 (0.03) ^{***}	-0.29 (0.03) ^{***}	0.00 (0.02)		0.01 (0.02)
Task orientation	0.02 (0.03)	0.08 (0.02) ^{***}	-0.14 (0.02) ^{***}	-0.01 (0.02)		0.03 (0.02)
Frustration tolerance	0.01 (0.04)	0.04 (0.03) [*]	-0.36 (0.03) ^{***}	0.01 (0.02)		-0.02 (0.03)
<i>Executive functioning</i>						
Backward digits span	0.04 (0.03)	0.08 (0.02) ^{**}	-0.05 (0.02) [*]	0.00 (0.02)		-0.03 (0.02)
Pencil tap	-0.05 (0.03)	0.10 (0.03) ^{**}	-0.06 (0.03) [*]	0.01 (0.03)		-0.02 (0.03)
Head-toes-knees-shoulders	0.02 (0.03)	0.08 (0.03) ^{**}	-0.07 (0.03) ^{**}	0.01 (0.02)		0.00 (0.03)

Notes: All continuous variables have been standardized to have a mean of 0 and SD of 1 and, therefore, all estimates reported above correspond to effect sizes. Estimates in brackets correspond to standard errors.

Because the variables above have been standardized, the main effect coefficients were the same across both the interaction and main effects models. All models control for the covariates listed in Table 1.

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .10$.

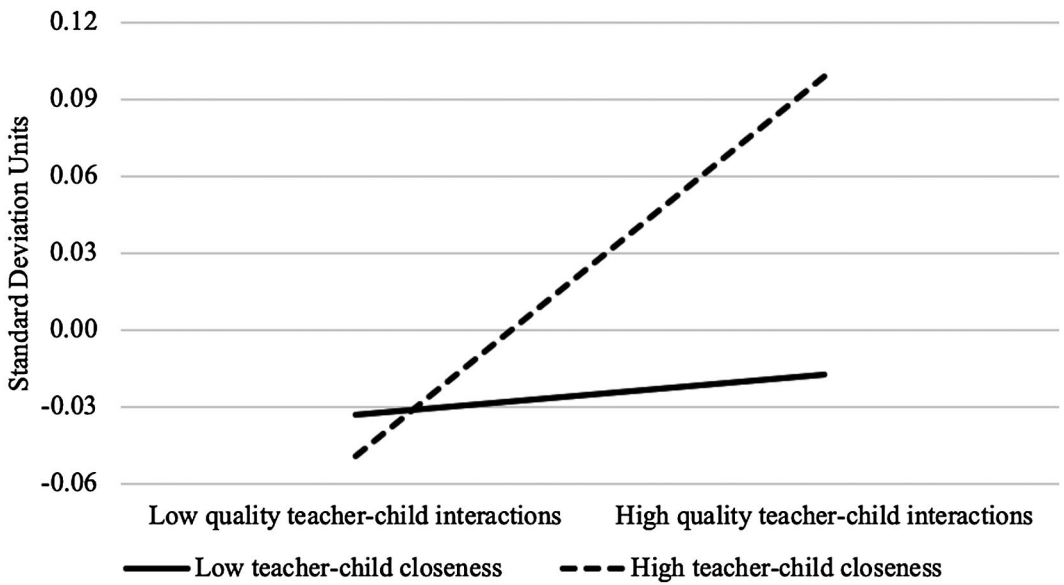


FIGURE 1 An illustration of the conditional effects of classroom quality as a function of teacher-child closeness. Although the figure used data from the classroom quality × teacher-child closeness in predicting children's performance on the Quantitative Concepts subscale of the Woodcock-Johnson, all other interactions followed a similar pattern

To facilitate interpretation of these significant interactions, we plotted the predicted outcome scores for different combinations of our predictor and moderators using *SD* cut points. In general, these interactions suggested similar patterns. We illustrated these findings with a plot for the interaction between closeness and quality in predicting Quantitative Concepts. As seen in Figure 1, these interactions suggest that, in general, children did not benefit academically from high quality classroom absent high levels of closeness, or low levels of conflict with their teachers.

4 | DISCUSSION

The current study investigated whether the quality of teacher-child interactions at the classroom level as well as individual children's relationships with teachers in preschool predicted their end of year school readiness. As part of this effort, we also examined whether preschool teachers' reports of their closeness and conflict with children moderated the associations between teacher-child interactions and children's school readiness outcomes. We found that the quality of teacher-child interactions was not associated consistently with children's early learning; however, the quality of children's relationships with their teachers was linked with their academic, socio-behavioral, and executive function outcomes. Our results also provide some evidence to suggest that the benefits of high-quality classrooms are conditional on children's relationships with their teachers.

To begin, we found largely small and non-significant associations between the quality of teacher-child interactions and children's school readiness at the end of the preschool year. Although the majority of our estimates of the associations between the three CLASS domains and children's outcomes were not significant, with effect sizes ranging from zero to six percent of a *SD*, these estimates were not far off from the extant literature that has studied interaction quality and reported effect sizes of 0.05 to 0.10 (Burchinal, 2018; Perlman et al., 2016). One potential explanation for this lack of significant associations is that the CLASS scores were not always favorable, especially for Instructional Support, which was low in the study sample with values around two. Overall CLASS

scores simply may not have been high enough to boost children's early learning and, therefore, are an area in need of quality improvement. A second potential explanation for the null findings and small effect sizes reported in this study is the relative stability in children's academic (roughly 0.70), executive functioning (roughly 0.50), and socio-behavioral skills (roughly 0.70) across the preschool year. That is, the study children largely maintained their relative standing in the skill distribution across the preschool year, regardless of their experiences in the classroom (e.g., Ansari, Pianta, Whittaker, Vitiello, & Ruzek, 2019), suggesting that early intervention may be necessary.

Despite the largely null associations between interaction quality and children's early learning and development, our results revealed a more consistent link between the quality of teacher-child relationships and children's school readiness outcomes. More specifically, similar to prior studies (e.g., Hamre & Pianta, 2001; Howes et al., 2008; Liew, Chen, & Hughes, 2010), we found that teacher-child closeness was associated with stronger outcomes across all dimensions of development, with effect sizes ranging from approximately 0.05 to 0.10. Also, in accordance with the prior literature (e.g., Hamre & Pianta, 2001; Spilt et al., 2012), teacher-child conflict was linked with less optimal social-behavioral development and executive functioning, with effect sizes of 0.05 to 0.50. Although we did not study the specific mechanisms underlying these associations, a close- and conflict-free relationship with teachers is likely to support children's social-behavioral skills because it promotes feelings of security and increases children's comfort in school, which is of utmost importance during the early childhood years (Bowlby, 1969). A positive teacher-child relationship also can be protective for individual children who may be at higher risk for behavioral, social, and academic problems. These relationships also might provide children with the encouragement and support necessary to navigate learning challenges successfully in an academically enriching classroom. These possibilities are, of course, speculative and require attention in the future. In the meantime, however, it seems quite promising that even with the relative stability in children's skills and behaviors, a warm and supportive relationship with teachers can facilitate children's early learning and development.

Although we found little evidence of moderation when looking at children's social-behavioral development and executive functioning (see also Lee & Bierman, 2015; Rucinski et al., 2017), there was evidence for interactive effects of interactional quality and teacher-child relationships for children's academic achievement. Our pattern of results suggests that the quality of classroom interactions is conditional on the individual child's experience in the classroom, specifically their relationship with the teacher. The academic benefits of higher quality classrooms reported in this study were roughly 16% of a *SD* greater when individual children had closer and less conflictual relationships with their teachers than when children had more negative relationships with their teachers.

4.1 | Implications for developmental theory, practice, and policy

The results of the present study add to the developmental literature by highlighting the importance of accounting for individual children's relationships with their teachers when studying classroom processes and experiences and, in particular, interactional quality. From a teacher's perspective, close and supportive relationships with children can provide motivation to spend additional time and energy promoting children's development. Relationships characterized by conflict and discordant interactions, in contrast, can lead to tension, anger, lack of rapport, and thus, deter teachers' efforts to promote a positive classroom environment. Our findings speak to the growing need in understanding the links and conditions that underlie adaptive relational patterns between teachers and children. Doing so provides avenues to support the learning and development of children from diverse backgrounds, and particularly for those who are at high risk for poor outcomes as they progress through school.

We demonstrated the importance of the associations between teacher-child relationships and children's outcomes within a framework that concurrently considered the role of the larger classroom relational environment. When taken together, these results suggest that these relational processes are hierarchical. In order to improve the quality of classrooms in a way that yields consistent benefits for children's learning and development, a key target is promoting a close and positive dyadic relationship between children and their teachers first (Pianta

et al., 2008), and then, focus on classroom interactional quality (e.g., Pianta et al., 2017; Raver, Jones, Li-Grining, Metzger, Smallwood & Sardin, 2008). In moving the basic science of classroom processes forward, it will be important to consider the ways in which *individual* children experience the classroom and how that might moderate the overall effects of preschool (e.g., Vitiello, Booren, Downer, & Williford, 2012).

With respect to practice and policy, school leaders should consider additional training and supports for teachers to form and maintain positive relationships with all of their students, perhaps even coaching teachers to build and manage effective relationships with children with whom they have more conflictual relationships or who are at higher risk for negative outcomes (e.g., Williford, Wolcott, Whittaker, & LoCasale-Crouch, 2015). The implications for policy of this study, if replicated, could affect decisions to place children with certain teachers, in addition to in-service training for teachers of young children. Broadly speaking, process-oriented professional development that alters teacher–child relationship quality through more explicit actions related to knowledge or behavioral changes has been shown to be particularly promising (Sabol & Pianta, 2012; Sheridan, Edwards, Marvin, & Knoche, 2009). In these professional development models, teachers are provided with the knowledge, skills, and support within their individual classroom contexts and experiences in order to change teaching practices. Individualized feedback about teacher–child interactions can also help teachers to reflect on and improve their interactions with individual children and the class as a whole (Pianta, Hamre, & Allen, 2012). From a prevention perspective, the deployment of resources or applications prior to the emergence of a conflictual relationship could be especially promising for promoting and protecting children's optimal learning and development in the classroom context.

4.2 | Limitations and future directions

A number of limitations of the current study need to be noted. First, the interpretation of our results requires caution given the correlational design of the study. Though it is certainly true that the inclusion of a wide array of child, family, and classroom covariates lends greater confidence to our conclusions, replication of our findings is needed. As such, future studies should continue to test the independent and interactive effects of classroom interactions and individual relationships. Second, we measured a representative sample of children's developmental outcomes, but our assessments did not encompass all potential skills that might be influenced by schools and the outcome assessments did not map directly onto the curricula in use or the instructional focus at the classroom level. Accordingly, the use of these assessments may mask associations that might be detected if the assessments used were more proximal to children's classroom learning experiences.

Moreover, largest effect sizes reported in this study were between teacher-reported socio-behavioral skills and teacher-reported conflict with children, indicating issues of shared method variance. Although this is certainly a limitation of our work, it is important to note that single-source bias was not an issue for our measures of executive functioning and academic achievement, which were based on direct child assessments. Additionally, in the present study, we utilized an observational tool of classroom quality that has been used regularly in the developmental and educational literature, but the number of observations potentially limits our measure of the quality of classroom interactions. Although observers visited classrooms two to three times during the school year and during each classroom visit, observers conducted four cycles of observation, it is likely more observations would provide more knowledge about classrooms. Further, the unique interactions of each teacher–child dyad might not be captured well with global measures of teacher interaction quality. In order to tease apart specific teacher–child interactions that promote children's learning and development, researchers should also consider individual assessments and measures of teacher–child relationships.

Finally, it is important to note that our measure of teacher–student relationships was based on teachers' own perceptions of their individual relationships with students. The source of information and method of assessment is likely to influence the manner in which children and teachers' relationships are characterized. Although the majority of research on teacher–student relationships in preschool and the early elementary school grades has

employed teachers' reports of the relationship (Birch & Ladd, 1997; Hughes & Kwok, 2007; Saft & Pianta, 2001), children's perspectives on the quality of the relationship with their teachers also are important. Future research could incorporate a measure of students' own perceptions of their relationships with teachers to determine whether measures from different perspectives agree with each other and similarly predict children's learning and development. Some studies have found discrepancies in agreement when individual teacher–student relationship quality was measured from both teachers' and children's perspectives in the early (Wu, Hughes, & Kwok, 2010) and later elementary grades (Rucinski et al., 2017), suggesting the need for more multi-informant approaches to assessing these relationships. Going a step further, Hughes and colleagues (Hughes et al., 2001; Hughes, Im, & Wehrly, 2014) incorporated peers' perceptions of supportive and conflicted relationships between the teacher and classmates. Peers are an important third source of information for measuring teacher–student relationships that future studies may want to consider.

With these limitations and future directions in mind, the present investigation provides new evidence that academically, the quality of everyday classroom interactions in the form of instructional, emotional, and organizational may not be substantially meaningful for children absent close and conflict-free relationships with their teachers. Consequently, not modeling such interactive effects could lead to underestimating, or potentially overestimating, the direct effects of classroom quality and preschool programs more generally. To prevent these methodological concerns and better capture the complexities of development and education, it seems essential to integrate tools that measure individual children's classroom experiences in developmental and educational research.

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DATA AVAILABILITY STATEMENT

The data are not available publicly because of information that could compromise the privacy of the research participants.

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